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FURTHER OBSERVATIONS ON THE FEEDING HABITS OF THE OYSTERCATCHER (*HÆMATOPUS OSTRALEGUS*).

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Mytilus edulis.

In a previous paper* I gave the results of my observations on the manner in which the Oystercatcher feeds upon the Edible Mussel. There are, however, one or two matters to which it is necessary to return and some new observations to record. I stated that of Mussels buried under sand, as a rule only those are opened which present the ventral fissure, and at the time I expressed reasons for this limitation which further experience has confirmed. On another page I unwittingly created the impression that all Mussels under sand or mud are placed in a vertical position. This is, of course, not always the case. The meaning I intended to convey is that those Mussels which are placed in a vertical position under sand or mud must be opened through the posterior ends, owing to the presence of the mud which prevents the Oystercatcher from reaching any other part of the Mussel quickly enough to separate the valves. To this extent buried Mussels differ from those situated on the exposed banks where a Mussel, though it happens to rest in a vertical position, is not necessarily opened through the posterior end.

When watching the Oystercatcher engaged in turning over Limpets, I was much impressed by the nature of the preliminary

* "Notes on the Oystercatcher" ('Zoologist,' 1908, pp. 201–212).

stroke. It seemed to me analogous to the preliminary tapping of the Mussels which I have recorded as an endeavour of the Oystercatcher to see whether or not its bill would pass between the valves of a Mussel which was gaping slightly in the presence of surrounding moisture. Careful approaching and watching have, however, failed to reveal any Mussel with its valves separated to an extent likely to admit the bill, excepting, of course, at the hiatus on the ventral border. This being so, a new explanation is required of the tapping. More precise observation of the tapping shows that frequently in attacks on the dorsal border, and more rarely in attacks on the ventral border, the bill does not descend in the mesial plane of the shell, but obliquely inclined towards it, so that the bill strikes unevenly the cleft between the valves, and brings pressure to bear more on one valve than on the other. If the Mussel is relaxed and is taken unawares, that valve is depressed below the level of the other in the region of contact. That is to say, one valve is rotated off its neighbour, and an abnormal gap is formed between the edges of the valves which is sufficiently wide to admit the tip of the bill. The bill is then pushed in and moved into the mesial plane of the Mussel which can be opened up on the spot, or detached and dealt with in a more suitable place. The full beauty of this little manœuvre lies in the fact that entrance can be repeated apparently an indefinite number of times to the same Mussel, provided the bill is withdrawn in the way it entered. This is due to the persistent tendency of the Mussel to contract its valves firmly together in the abnormal, rotated position. This, then, appears to be the correct explanation of the tapping. It is an attempt on the part of the Oystercatcher to take a relaxed Mussel unawares, to rotate the one valve off the other by tapping, and thereby to gain admission to the shell. This conclusion was tested by experiments which added the following information. The valves cannot be rotated when the shells are dry and firmly closed. Rotation is impossible after the shells are warned by touching them, and also when the shells rest evenly on solid rock. While one shell is being experimented upon, the shells in the vicinity are audibly contracting their valves, and it is necessary to go a foot or two away before proceeding to tap another shell. The stroke must

be delivered obliquely into the cleft between the valves, and without too much force, in order to avoid injury to either valve. Rotation can be produced readily by a stroke made on the posterior end of a shell, provided it is made above or below the equator of the shell.

The largest Mussel I have so far found opened by an Oystercatcher measured two inches in length by seven-eighths of an inch in breadth (2 in. × $\frac{7}{8}$ in.). But this was quite an exceptional size. The shell had been detached and opened through the ventral fissure, and it showed no fracture.

Shells ranging from one and three-eighths inches in length by five-eighths of an inch in breadth ($1\frac{3}{8}$ × $\frac{5}{8}$) to five-eighths by five-sixteenths ($\frac{5}{8}$ × $\frac{5}{16}$) are sometimes treated in a way that differs from that ordinarily seen. The bird takes each shell in turn without selection except as regards size. A small patch of these Mussels may have the contents of every shell removed. The shell is hammered open by the application of a rapid succession of forceful blows directed obliquely through the point of the bill to the cleft between the valves, near the posterior end of the hinge. The blows crush a portion of that valve which has the more pressure to bear, and drive the fragments into the interior of the shell. The bill is pushed home through the newly formed opening, and is then employed, if necessary, to open up the shell by any one of the ways I have already described. The method can always be recognized at a glance by noting that there is no preliminary inspection or tapping; the bill is raised clearly off the shell in the intervals of the succession of blows; there is no real downward progress until the final blow breaks the shell; there is an extraordinary hurry and display of brute force; and very often there is no laterally inclined or rotary leverage, as the blows usually make a hole in the shell big enough to allow of the whole contents being removed without separating the valves, or the leverage and scooping up of the contents are combined in one operation. The peculiar manner of hammering the shell distinguishes this method from the more usual one in which the bill is pushed home between the valves by a series of thrusts without intermediate recoil, and in which leverage is always requisite to open up the shell and allow of the contents being removed. Shells which present the ventral border are

also hammered, and the blows are delivered into the hiatus in the border of the shell. That this should be so in the absence of any apparent necessity to hammer is peculiar, but it probably represents the continuity of a habit fixed for the time being. The hammering method has two advantages and a number of drawbacks. It is a rapidly and fairly assured way of getting food. The birds may be seen to rush from one shell to another, hammer each one open in turn, lever the valves apart if necessary, and wolf the contents. In three minutes a single bird opened and cleared twenty-six shells, varying from one inch to three-quarters of an inch in length. Another worked at an average rate of seven to eight shells per minute, the shells varying from seven-eighths to five-eighths of an inch in length. It maintained this speed for three-quarters of an hour, and continued to open shells, though less quickly, for another quarter of an hour. Thus it must have cleared the contents of upwards of four hundred shells in one hour. The drawbacks are considerable, but they evidently do not outweigh the advantages of rapidity and comparative certainty. The output of energy is enormous. One can scarcely doubt that the birds are making violent exertions, and, though a small amount of visual selection is exercised over the sizes of the shells as the birds hurry from one to another, yet a considerable proportion of the shells successfully resists the hammering, and the birds have, perforce, to pass on to others. As a rule, five to eight strokes with the point of the bill are sufficient to perforate the shell. In one case the bird returned three times, making four attacks altogether on a single shell. Each attack consisted of twenty to thirty powerful blows, making some eighty strokes in all, before the onslaught met with success. In another, the bird hammered five or six times without result. At once pressing the point of the bill firmly and obliquely on the summit of the shell, it walked round through quarter of a circle, and in its new position applied several thrusts downwards. Still keeping up pressure, it walked back to its old position and hammered seven or eight times, the last stroke sending the bill deeply into the shell. In other cases the hammering was preceded by firm pressure of the point of the bill on the summit of the shell for a few seconds with, at the same time, vigorous shaking of the

bill sidewise. These examples indicate the difficulties the birds sometimes meet with, and they also bring out an interesting point. In the ordinary Mussel shell presenting the dorsal border the two valves meet at an acute angle, and by their mutual interaction offer the maximum resistance to pressure from without. Partly from direct observation and partly by the inspection of the shell-remains, it became clear that the special purpose of the two manœuvres last described was to rotate the one valve partially off the other, thereby to deprive the one of the other's support, and so make it the more easily crushed. In these two cases the attempt was made to depress the one valve below the level of the other by sheer force in small and comparatively weak Mussels which were, however, presumably resisting to their utmost. A third disadvantage is brought to light by examining the Mussels after the birds have left. The shells are usually cleaned out *in situ*, and, in general, it is not common for a shell opened by hammering to be removed to a bare place as a preliminary to the removal of the contents. Most bear evidence of having been opened through the dorsal border, and show the ordinary line of fracture extending from a point on the border posterior to the hinge to the anterior end. When the elliptic portion remaining with the hinge is broken into two portions, the posterior part shows marked depression. In addition, when the two valves are approximated, a hiatus remains in one valve posterior to the hinge, and generally the part corresponding to it is found in fragments inside the shell. In some shells this hiatus alone is present, and shows that levering had not been necessary.* A few show that they were hammered open through the posterior end, and a still smaller number through the ventral cleft. In these last the bill was driven truly between the valves, but the margins show signs of rougher usage than do the margins of shells opened by thrusting, and, as in the majority of these, there is no fracture. The shells are rarely well cleaned, the attachments of the mantle to the valves being generally left untouched, and the birds refuse those portions of the flesh which have got mixed with the fragments of the shell driven into them

* *Cf. ibid.*, p. 204, where I have advanced the depression of the posterior fragment and the presence of a hiatus as material evidence of the *accidental* opening of the larger shells where no leverage was required.

by the process of hammering. There is, thus, a considerable loss of feeding material. This loss is the third disadvantage of the method.

Still smaller shells—that is, those ranging from five-eighths of an inch to half an inch in length ($\frac{5}{8}$ in. to $\frac{1}{2}$ in.)—are treated in a cavalier fashion commensurate to their feebler powers of resistance.* They may be entered by a single, even, downward thrust of the bill between the valves and then levered open, or they may be hammered open with or without subsequent leverage. These shells are much crushed. Sometimes they are seized crosswise within the tips of the mandibles, and either jerked from their anchorage, or pulled off with an apparently gentle to and fro motion of the bill, or levered up by raising the tip of the bill and depressing the head, a neighbouring shell being used as a fulcrum. These easy ways differ markedly from that accorded to the larger shells, which need powerful tugging to detach them from the rocks. Then, the shells which have been removed so easily are set down on a bare place and hammered open. If wide separation of the valves is necessary, the requisite leverage is very often combined with scooping-up of the contents; and the acme of the process is reached when a bird enters a small shell either by thrusting or hammering, jerks it off the rock, scoops up the contents in mid-air, and casts away the empty shell by a vigorous shake of the head, leaving the soft body of the Mussel within the tips of the mandibles. This proceeding takes place so quickly that it is inconceivable the bill can have been introduced into the shell otherwise than slightly open, and in one instance, at least, I believe the relative positions of the mandibles never changed from the beginning to the end of the operation, though at no time was it possible, as viewed at the range of observation, to say that the mandibles were even separated.

Modiola modiolus.

The Oystercatcher searches for immature individuals of the Horse Mussel near low water and in the pools between tidemarks. Very often the shells are scattered rather than crowded

* *Cf. ibid.*, p. 210, where a method of opening these shells is first described.

together, and, as a rule, they are well hidden amongst vegetation, or in the sandy concretions of diverse materials that clothe the rocks in many places. In consequence, the search for *Modiola* takes the form of a close and extensive inspection, with frequent, vigorous probing into the concretions in selected spots. The shells are entered and opened up precisely as if they were those of the Edible Mussel. But in the majority of cases they are dragged from their anchorage before being levered widely open and cleared of their contents. This difference is no doubt due to the difficulty which would be experienced in separating the valves amongst matted vegetation or miscellaneous concretions. After detaching the shell, the Oystercatcher selects some kind of support, such as a crevice in the rock, on which to rest the shell before levering it open. A support is the more necessary when the shell has been entered through the hiatus in the ventral border, owing to the rounded form of the dorsal surface. For a similar reason nesting is occasionally employed.

The shells vary in size from two and a quarter inches in length by one and a quarter inches in breadth (2¼ in. × 1¼ in.) to nine-sixteenths of an inch in length by five-sixteenths of an inch in breadth ($\frac{9}{16} \times \frac{5}{16}$), the average size of a hundred shells being one and three-sixteenths inches by five-eighths of an inch ($1\frac{3}{16} \times \frac{5}{8}$). These hundred shells include eleven which were opened by the hammering method. Of the eleven, the largest measures one and a quarter inches by five-eighths of an inch (1¼ in. × ⅝ in.), and the smallest as given above, the average size being fifteen-sixteenths of an inch by seven-sixteenths of an inch ($\frac{15}{16}$ in. × $\frac{7}{16}$ in.). The smallest shell opened by the thrusting method measures five-eighths of a inch by three-eighths of an inch (⅝ in. × ⅜ in.). The biggest shell of the whole series is exceptionally large. It had been entered through the hiatus in the ventral border, and was uninjured. Of the hundred shells, sixty-four were entered *viâ* the ventral border, six through the posterior end, and thirty by the dorsal border. These figures roughly reverse the percentages obtained from *Mytilus edulis*. The cause, as in the latter case, is to be found in the natural position of the shells. In *Modiola* the habit of living more or less hidden under vegetation and other cover allows, apparently, of the assumption of various attitudes, and,

as a matter of fact, by far the commonest position is a more or less oblique one with the ventral border superior. Of the eleven hammered shells included in the general total, ten were opened through the dorsal border, and only one through the ventral.

Owing to the great development of soft epidermis in the growing *Modiola* as compared with the thin covering of *Mytilus*, it is possible in a large number of shells to see, from the marks made by the pressure of the bill, where the bill was introduced between the valves. The study of these impressions confirms the results obtained more or less indirectly from *Mytilus*. When the bill is pushed into the shell through the dorsal border and leverage is applied, one valve splits along a curved line extending from a point near the posterior end of the hinge to the anterior end. When the bill is introduced through the ventral hiatus, no fracture is caused, as a rule, and if one does occur it runs transversely across the shell, or more rarely it takes a quadrangular form. In one of the shells opened by the thrusting method, the bill, after being pushed into the shell through the hiatus in the ventral border, had perforated a worn part of the shell an eighth of an inch obliquely behind the posterior end of the hinge; in another case entered similarly, the bill had been pushed through the dorsal cleft just behind the hinge, causing comminution and eversion of the edges of the valves at that point. In two of the hammered shells the blows had been delivered so evenly between the two valves in each case that a semi-ellipse of each valve had been driven inwards before the bill. As it happened, one shell had been attacked at the summit of the dorsal border, and the other through the hiatus in the ventral border.

Tapes pullastra.

The shells of *Tapes pullastra* are found in the same localities as are those of the Horse Mussel. But, in comparison with the latter, the *Tapes* are much better hidden from sight under vegetation, in sandy concretions, or in colonies of *Mytilus*, while a proportion of them resides in the holes made by rock-boring molluscs. The Oystercatcher discovers the shells by a laborious process of inspecting and probing the materials in which they are imbedded, and having found a shell it has usually no difficulty in gaining admission, owing to the great protrusion and slow

retraction of the foot and the syphons. The bird forces its bill well in between the valves by a series of powerful downward thrusts which merge imperceptibly into as powerful upward jerks, for the purpose of extracting the shell from its home. The shell is then carried to a suitable crevice in the rock, on which it is deposited hinge downwards, and where it is opened up by firmly applied lateral leverage. The mollusc is torn out in successive portions, adherent fragments of shell, if any, being vigorously shaken off before each mouthful is swallowed. The greater number of the shells is detached apparently for the same reason as that applying to *Modiola*, and, owing to the form of the region of the hinge, a support to the shell is essential before leverage can be applied. The bird may spend some time in uncertain wandering in search of such a place, and once a suitable crevice is found it may be used repeatedly by nesting the shells. Usually a depression in the rock is utilized, but an irregularity in the concretionary matter adhering to the rock or a bristly tuft of vegetation will serve. I found a shell resting between a Limpet and a low ridge of rock, and another placed endwise against the same ridge.

Of one hundred and six shells, the largest measures one and an eighth inches in length by one and a half inches in breadth ($1\frac{1}{8}$ in. × $1\frac{1}{2}$ in.), and the smallest three-eighths of an inch by five-eighths of an inch ($\frac{3}{8}$ in. × $\frac{5}{8}$ in.), the average being eleven-sixteenths by fifteen-sixteenths ($\frac{11}{16}$ in. × $\frac{15}{16}$ in.); 77 per cent. are entire and 23 per cent. are fractured. The lines of fracture are very various, and bear no apparent relation to the size of the shell. Perhaps the commonest form is a transverse fracture about the equator of one valve, with comminution of the ventral portion. But vertical and oblique fractures are not infrequent, removal of either the anterior or the posterior end of one valve sometimes occurs, and a general crushing of the valve is by no means rare. Owing to the comparative hardness of the shell and the absence of epidermis there are seldom marks to indicate the mode of entry. I have found abrasions at the middle of the ventral border in a number of cases, and in one a V-shaped nick had been made in the truncated end of one valve. Judged by direct observation, the usual mode of entry is through the ventral border.

The treatment of shells situated in *Pholas* or *Saxicava* borings depends on the amount of room around the shells. If there is plenty of room, the shell may be extracted and dealt with as in the other cases, or it may be laid open and cleared of its contents *in situ*. If the shell is a tight fit so that it can neither be expanded nor extracted, a fragment is broken transversely off the end of one valve (the posterior end) by vigorous lateral leverage, and through the enlarged opening the contents of the shell are removed.

Pholas crispata.

On each of several occasions, when watching Oystercatchers at work on the shales, I saw one bore very deeply through the sand-covering portions of the shale, and shake the bill vigorously and repeatedly from side to side in such a way as to suggest that the bill was being resisted laterally by the solid rock. Swallowing movements followed in each case without the bill having been withdrawn into view. Though suspecting *Pholas*, I was unable to exclude the possibility of a deeply seated *Tapes*. At the same time, I was aware that many borings occupied by live *Pholades* were wide enough at the entrances to admit freely the bill of an Oystercatcher. The matter was eventually settled by the discovery of a *Pholas crispata* in a pool not far from an empty boring in the shales, and soon after the Oystercatchers had left. The two valves had been separated, and lay on their external surfaces slightly apart. One valve had been fractured transversely an eighth of an inch from the posterior end, which was awanting. Fragments of flesh were still adherent to the valves, showing that the specimen had been recently opened. The entire valve measured nine-sixteenths of an inch in length by seven-eighths of an inch in breadth. The apophyses were intact.

Purpura lapillus.

Since the preliminary note relating to this species was printed,* I have examined two hundred and ninety-four shells, all of which bore evidence of having being dealt with by the Oystercatcher. Of these, four (1 per cent.) reached the first stage of opening, and sixty-one (21 per cent) the second or completed stage, the remaining two hundred and twenty-nine

* 'Zoologist,' 1910, pp. 109–112.

(78 per cent.) being accounted failures. Of the sixty-one which reached the second stage, four (6·6 per cent.) were completely opened up in one stage, shell being extruded, in each case, equal in area to that more usually extruded in two portions. The average size of fifty-six shells which reached the second stage was fifteen-sixteenths of an inch ($\frac{15}{16}$ in.), the largest being one and one-eighth inches ($1\frac{1}{8}$ in.), and the smallest thirteen-sixteenths of an inch ($\frac{13}{16}$ in.). The four shells reaching the first stage averaged one and a sixteenth inches ($1\frac{1}{16}$ in.), the largest being one and one-eighth inches ($1\frac{1}{8}$ in.). A longer series, however, would probably lower the average. I did not systematically measure the failures, as they did not show visually any variance from the others. The largest measured was one and one-eighth inches ($1\frac{1}{8}$ in.) in length.

By direct observation I have seen all the methods in use at each stage of opening the shells—thrusting, hammering, or longitudinal rolling at the first stage; lateral leverage, thrusting, hammering, or longitudinal rolling at the second. Often the several modes are put in force successively when strong resistance is encountered. The birds appear to vary in the degree of pertinacity with which they attack the more difficult shells, some birds giving in after a single bout, others returning repeatedly and with renewed energy. In the first paper I recorded the introduction of the upper mandible alone into the aperture of the shell. This fashion occurs but rarely, and in some cases, at least, is apparently dependent on the mode of carrying the shell by the outer lip. The more usual plan is to carry the shell crosswise between the tips of the mandibles, and to insert the bill into the interior of the shell for the purpose of opening it.

An examination of the failures yielded some interesting results when the shells had been dealt with on rock. As a rule, each presented on the lower surface of the last whorl a single bulb of percussion, at a point on the external surface corresponding roughly to the edge of the operculum inside, and in the second stage, when not completed, at a point in line with the margin of the first opening and the edge of the pillar. Experimentally, similar bulbs can be produced by making five or six thrusts inside the shell, but it is difficult to adhere to a single

spot. In a few of the naturally treated shells, several or many bulbs were present. In some, longitudinal or oblique scratches or grooves were visible on the lower surface of the last whorl, and usually had associated with them a diffusely abraded area on the lower surface of the second last whorl. These scratches cannot be reproduced by simple longitudinal or obliquely inclined rolling of the shells under pressure. It is necessary, in addition, to impart a small amount of bodily movement to the shells in the direction of pressure.

Patella vulgata.

According to Robert Gray,* the Oystercatcher inspects the Limpets one after another, in order to see whether or not the shells are at all raised from the rock. On meeting such a one the bird promptly pushes its bill under the Limpet, and neatly turns it over. One foot is then placed on the shell, and the body of the animal is "taken out as cleanly as if done with a knife or other sharp instrument."

When the Oystercatcher is about to overturn a Limpet it lowers its head and inclines the bill at a low angle towards the ground, the attitude and purpose of the bird being similar to those of a battering-ram in action. For a reason which I shall explain immediately, the bill is directed downwards and forwards, with its sides at right angles to the plane of the ground. In this peculiar attitude the Oystercatcher delivers a sharp push or chipping stroke to a portion of the edge of the selected Limpet. With a small Limpet the stroke, if successful, shifts the animal bodily from its seat. The advancing edge of the shell catches in some obstruction, and the shell topples over. With larger shells the stroke has usually to be followed up by firm and evidently laborious pushing, assisted, it may be, by swaying of the bill from side to side, with finally a raising of the head and the bill, or a to and fro rotation of the bill through barely a quarter of a circle. In these larger shells the bill is obviously forced under the animal, and the process of overturning is usually completed by means of some more patent form of leverage. The Limpet is then seized and carried by the flesh, the edge of the shell, or by being held in the line of its breadth

* 'Birds of the West of Scotland,' p. 270.

within the tips of the mandibles. It is deposited in a suitable crevice of the rock or on sand, and the contents are separated from the shell by chipping through the friable attachments of the mollusc to the internal surface of the shell, the process of detachment often being completed by the bird shaking its bill, and flicking the shell off the body of the mollusc as the head is raised.

The shells vary from one and three-quarter inches in length by one and a half inches in breadth ($1\frac{3}{4}$ in. × $1\frac{1}{2}$ in.), to half an inch in length by seven-sixteenths of an inch in breadth ($\frac{1}{2}$ in. × $\frac{7}{16}$ in.), the average size of one hundred and thirty-four shells being seven-eighths of an inch by eleven-sixteenths of an inch ($\frac{7}{8}$ in. × $\frac{11}{16}$ in.). Out of one hundred and sixty-one shells, 85 per cent. are whole, or at most only abraded at one part of the margin of the shell, and 15 per cent. are fractured. In the series the occurrence of abrasion and fracture has no visible relation to the size of the Limpet, and no recognisable rule of position in relation to the margin of the shell. The fracture may be a small V-shaped chip out of the edge of the shell, a larger quadrangular fragment, or, as in a few cases, it may be semi-annular. The shells are invariably well cleaned. They are carried in about equal numbers to crevices in the rock and to sand for the purpose of removing the contents. In no case was a footmark impressed on the sand so as to overlap the shell, or its mark if the shell had been flicked away. In each case a wide gap separated the shell or its impress from the corresponding footprints. This agrees with my observations. I have not as yet been able to detect an Oystercatcher in the act of steadying a shell with one of its feet. On rock, evidence of equal value cannot be adduced, but some sort of support is of invariable occurrence in order to render the shells stable during the removal of their contents. Usually it takes the form of a crack or depression in the rock. Further, nesting of the shells is common for the same purpose, two, three, or four being piled one on the top of another, in each case as a preliminary to the extraction of the mollusc. On one occasion I found a nest of five *Tapes* and three Limpets in that order from below upwards.

After going over the evidence derived from direct observations, and from an examination of the shells, I feel there are at

least two matters which demand further explanation. One is the peculiar attitude of the bird in the moment of the attack, especially as regards the bill, and the other the nature of the pushing or chipping stroke. Having repeatedly verified the original observation that the bill is held with the sides vertical in the operation of overturning a Limpet, I have no doubt that it is actually so, and the problem comes to be, Why does the Oystercatcher instinctively ignore the expediency of pushing the bill flatly under the Limpet? The answer is bound up with the nature of the sharp push or chipping stroke. In the first place, a Limpet, when bone dry externally, adheres to the rock so tenaciously that no pressure likely to be within the capacity of the Oystercatcher is able to move it. In the second, a Limpet, when it is moist as in a pool, in the tidewash, or soon after the ebb has left it, is generally relaxed and slightly raised from the rock. The Limpets which fall into the second category are those sought after by the Oystercatcher, and it is an additional advantage if there be a slight irregularity, either in the shell or the surface of the rock, at one point on the margin of the shell. When, however, one of these Limpets is experimentally warned by tapping it gently, it draws itself tightly on to the rock, and passes into the first category. Thus the main essential is apparently a taking of the Limpet unawares, and a secondary advantage the existence of a slight local increase of the normal gap between a relaxed shell and the rock. Limpets, of course, are to be found in the tidewash with the shell separated from the rock more than enough to admit the depth of a bill, and others are attached to such hopelessly irregular pieces of rock that the insertion of the bill is an easy matter. On the other hand, a Limpet, whether it is relaxed or holding firmly, is absolutely safe when it is sunk in a depression of its own making in the rock. For such as these the peculiar method of the Oystercatcher is not called into play. After the tide has receded, and even before the rocks have dried, the average Limpet presents so small a crack between the shell and the rock that it would be impossible to push the bill under the shell without the aid of some special mechanism. This is supplied by the sharp push or chipping stroke. When it is made experimentally in the case of the smaller shells, the result is exactly as I have described it

from direct observation of the Oystercatcher at work. With the larger shells, while it is easy to reproduce the natural occurrence, it is not so easy to find out what actually occurs during the rapid succession of events. The blow must be delivered at a low angle; otherwise it serves merely to warn the Limpet to settle down more firmly on the rock. And the instrument must be held with its sides, or rather the plane of its depth, at right angles to the plane of the ground. I find that at the moment of the stroke, made under these conditions, the instrument representing the bill does not pass under the shell, but gives a sharp blow to the edge of the shell. The blow shifts the Limpet bodily a fraction of an inch in the direction of the pressure. The animal then holds on, and the upper part of its body undergoes distortion, pressing the advancing edge of the shell firmly on to the rock, and raising the near edge against which the instrument is pushed. In some cases this proves sufficient. If the shell is out of the water, and the stroke has been made quickly, a rushing sound is heard, as of air passing in under the foot, and the shell topples over. In others the instrument must be passed under the shell. To do this, hard pushing is required to distort the body of the Limpet, and to raise the near edge of the shell still more. Probably the obliquely truncated tip of the bill, as it occurs in at least some Oystercatchers, assists in raising the edge of the shell under pressure. After getting the tip past the edge of the shell, the instrument must then be pushed under the edge of the foot, a proceeding which is made easier by swaying the instrument from side to side. This manœuvre produces an abrasion on the edge of the shell similar to that proceeding from a similar cause in nature. As soon as the instrument passes to a varying distance under the foot the rushing sound is heard, and the shell topples over. If, however, the movement is carried out slowly the rushing sound is not heard. Leverage by raising the base of the instrument is a disadvantage at an early stage, as in the likely event of failure the Limpet gets a better grip of the rock during the return movement. It, however, hastens the overturning when the hold of the animal is weakening. Instead of this form of leverage, rotation of the instrument through barely a quarter of a circle is equally helpful at this later stage. Experimentally, the instrument passes more easily under the

shell, with its sides parallel and not at right angles to the ground. But the Limpet is well able to retain its hold, owing apparently to the slight separation of the foot from the rock. No rushing sound is heard. Leverage proves impossible, and when it is tried the steel instrument bends under the strain to the point of snapping. Further, its withdrawal, after the failure to overturn the Limpet, is a matter of very real difficulty. Thus the use of the bill, with its sides vertical to the ground, is an advantage and a safeguard. It necessitates the edge of the shell being raised to a greater height than is the case when the bill is used flatly; it favours, by this greater separation, first, of the edge of the shell, and, secondly, of the edge of the foot from the rock, the entrance of air or water under the foot; and it renders the withdrawal of the bill from under the Limpet more easy in the event of failure.

Though in the above description I virtually make out that the admittance of air or water is essential to the overturning of the shells, my strict position is that in many cases a rushing sound is heard just before a shell which is out of the tide topples over, and the sound is more like that of air entering a vacuum than of air escaping from a cavity under pressure.

Tectura (Acmæa) testudinalis.

I found one shell of this *genus* and *species* amongst a quantity of Limpets which had been overturned by the Oystercatcher. It measured five-eighths of an inch in length by half an inch in breadth ($\frac{5}{8}$ in. × $\frac{1}{2}$ in.), and was fractured at the larger end. Some friable material still remained along the line where the body of the animal had been attached. The record is interesting, if only on account of the evenness of the edge of the shell, which does not favour an attack at any particular part of the circumference.

A DIARY OF ORNITHOLOGICAL OBSERVATION MADE IN ICELAND DURING JUNE AND JULY, 1912.

By Edmund Selous.

On May 29th, 1912, I sailed—or rather steamed—for Iceland, and was met on board, on June 2nd, by Mr. Sigurdsson, with whom I had arranged to stay. We reached the farm, travelling in the usual way—on ponies, that is—on the 4th, and set out next morning for some cliffs, overlooking a large lake, at no great distance, amidst the ledges of which a pair of Sea-Eagles (*Haliaëtus albicilla*) had for years laid their eggs, which had for the same time been sold to various daring men whose enthusiastic love of nature had led them to these undisturbed, wild spots, with no other purpose than that of making such romantic purchases from the very hands of the native inhabitants in them, or of the far-travelled dealer. Our course lay along the bank of a river which, issuing from the great lake (now close at hand) rushes along in an impetuous, boiling torrent, amidst rocks and great cliff-like fragments fallen from its banks, which here form veritable precipices. Dismounting a little above the outlet, where the lake forms a small bay, we crossed it in a very little boat, with a very big leak in it, through which the water poured almost as fast as I could bail it out, and which the waves seemed every moment on the point of swamping altogether. Owing to its being so rough, we had to land immediately opposite to the point from which we started, instead of rowing to the vicinity of the eyrie, which necessitated carrying everything up to the top of the cliffs, and then, proceeding along them, to descend at a point where they again became scaleable, a little beyond the place. First, however, we visited it *expeditus*. Before we had gone very far, one of the Eagles went up from somewhere along the line of cliffs, and floated majestically, high above us, uttering, at intervals, a monosyllabic note, quickly

repeated some five or six times, which, though it might be rendered as "yap, yap, yap," yet bore little resemblance, I thought, to the bark of a dog, to which it has been likened. To this was added a shriller cry, recalling that of the Sparrow-Hawk or Kestrel, but louder and more powerful in proportion (or perhaps not quite in proportion) to the superior size of the bird. Soon the other Eagle appeared, and the two, as they floated grandly together, not seeming to move, yet covering wide distances in their majestic circlings, presented a magnificent spectacle. When we had got down on to the beach of the lake, Sigurdsson pointed out to me a certain area of the cliffs rising out of the steep, green slopes, strewn and embedded with boulders and huge rocky masses, at one or other point of which the nest was certain to be, but long searchings with the glasses failed to reveal it. It was, indeed, absolutely hidden from below, amidst the grass and tall, burdock-like plants, mingled with flowers, which covered the particular ledge that the birds had chosen, so that when one of them, at last, descended upon it (it was like the wind, in a shape, sweeping down), I could do no more than distinguish the head and hooked beak, with its lurid yellow sere, which, however, was sufficiently exciting. During this time Sigurdsson had gone off to make inquiries of some shepherding boys, whose house was in the neighbourhood, and with whom he, before long, returned. Detailed information in regard to the site of the eyrie was now given by the boys, which, however, I sitting still had anticipated. I had seen something more, too, for, whilst watching their glorious, imperial rule of the air, both birds together came down on the bare, rounded summit of a hill, just above the cliffs that it topped. Here they stood, for a little, and, when they took flight, again, I noted that they rose by simply spreading their wings—those "sail-broad vans"—and floating away on them. There was not one flap or even quiver—they simply soared from the ground.

The site for pitching the tent—by no means an ideal one—the site I meant, but this applies to the tent as well—having been decided upon, we now—Sigurdsson and myself, the boys had gone—started back to bring it on. First, however, a boy, who had accompanied us on foot, and been left on the other side of the

lake, with the horses, had to be rowed across (an operation which I watched), after which a partition was made of the baggage—on principles somewhat more than equitable towards myself, but I had to submit—and we laboured along with it, getting to the place, again, about 7 p.m. We found the female Eagle in possession of the eyrie, nor did she leave it during all the time in which we were engaged in setting up the tent—which perforce was nearer than I should have wished it to be—or in getting moss round about to fix in the meshes of the netting which I had brought to go over it. Shortly after 8, I was left alone in the tent.

8.15.—Bird off nest, and joins her partner in the air, as he sails grandly up. The two float together, for a little, and there comes from one, or both, the cry last referred to, which can certainly be described as a squealing, or even squeaking one. Then, after a few circles, one of the Eagles (I think the same one) returns to the nest. The nest was empty for about eight minutes. The returning Eagle, as it flew in, before commencing the circling descent, with legs stretched down, which is such a joy to witness, made a few flaps with the wings, and this is the first time I can recall their being moved, at all, by either of the birds. They have, till now, simply floated upon them, stretched to the uttermost, the tips of all the primary quills being separately visible against the sky (now blue and bright as that of Africa—long may it keep so !), their outlines sharply drawn, and not blurred, exactly as Darwin has remarked of the Condor of South America. The shape of the wings, when thus outstretched, is much that of the conventional Eagles on flags—*e. g.* those of Germany, Russia, and Austria. Indeed, there was a much greater resemblance to these crude productions than to any serious rendering I can recall, which makes me think that the former may perhaps owe their origin to the keen eye and unerring hand of generations of Stone-Age ancestors who kept seeing the beasts that they drew. Even the absolute black of these bannered Eagles is not quite so extravagant as one might think, for the real bird looks dark enough in the air. For obliterative purposes, at any reasonable distance, he would need a specially designed sky. Such a one as he floats in now could only help the Blue Bird, or that splendid cerulean variety of the

Raven (unhappily very rare) depicted in Section I. of Kirkman's 'British Bird Book.'* It would, I suppose, be quite useless to appeal to collectors to spare the eggs of this bird. They are, indeed, indistinguishable from those of the common form, but so were the St. Kilda Wren's.

At 8.45 there is the cry of Gulls in the air—the "ow-oo, ow-oo" of the Great Black-backed—and the partner Eagle floats up. The Gulls have the impertinence to molest him, but he floats grandly away from them each time that they stoop at him. As he passes in the line of the eyrie, and not now much above it, the sitting bird flies out to him, with a shrill little "quee, quee, quee, quee," as of greeting—such a cry as might be uttered by a much smaller creature. I keep the two great birds distinct, and it is the newly arrived one, who, after a circle or two with, or, rather, in the proximity of its mate, now flies in to the cliff, and takes the place of the latter on the nest. Thus there has been a change upon it, but the sitting bird has gone off, whilst the other was still on the wing. It may very well have been the same, therefore, on the former occasion, though I did not think so at the time. In any case, both sexes incubate.

Just about 9 there is an extraordinary croaking noise which, at first, I take to be made by a Raven, but which turns out to proceed from a Grouse or Rock Ptarmigan—*Lagopus rupestris*, unless the name has changed lately—which, a moment afterwards, flies, in a wild, tumultuous way, down from the cliffs, either on to a large rock, against which the tent is pitched, or on to the tent itself—now all over patches of moss—and there makes still more extraordinary sounds, which I am quite unable to transcribe. It seems like a call or challenge, but nothing, I believe, comes of it. Earlier in the afternoon I had seen one of these birds, for the first time. My attention was directed to the rock on which it sat, and with which, as a general proposition, it harmonized. Also, as a general proposition, I could not, for some time, see the bird, but I did see, very quickly, a particular part of it, namely, the patch of red above the eye, and this blazed out so brilliantly that I at first thought, with wonder, that I was looking at some gorgeously plumaged small bird, and then did not know what to make of it. Of course, predaceous

* Plate i., to face p. 10.

species, accustomed to prey on the Ptarmigan, would know very well what to make of it, and the vermilion spot, once seen, would instantly betray the bird. I saw nothing whilst I was in Iceland to harmonize with this brilliancy, or which it could be supposed to simulate. If the general coloration of the plumage, therefore, is protective, and due to natural selection, it is impossible that something which violently contradicts it, and must go far to discount its good effects, can have been acquired in the same way. It is only during the breeding season that this brilliant comb or wattle appears, so that we have here something which seems obviously due to the agency of sexual selection, and the very fact of its being altogether antagonistic to the protective principle which has, in general, asserted itself, bears evidence to the importance of the results brought about through this agency. A special object has, at a special time, to be achieved, and it is worth while achieving it even by the temporary suspension, or partial relaxation, of those measures which have been taken to ensure the more general object. Natural selection, on this view, does all that it can to protect the male bird from outside hostility, throughout the year, consistently with allowing it sufficient facilities for recommending itself to the female bird, in competition with rivals (inside hostility) during a certain season of the year.

It is now 10.30 p.m. There is a great silence and stillness, and though perfectly light, so that I am writing this without a candle, still there is something—a sort of deadness in nature—which seems to proclaim it to be night. The sitting Eagle, at any rate, seems to have taken her place for the night, whilst her mate has not been visible since the last change, and is probably roosting somewhere in the vicinity. Each time that these Eagles have come on to the nest, they have made movements upon it, before settling down on the eggs, which I have not been able satisfactorily to follow—they seem much more than should be required for the turning or otherwise moving the eggs.

Besides the Gulls, as I have noted, a pair of Ravens, earlier in the day, molested, or attempted to molest, one of these Eagles.

June 6th.—About 4 a.m., as I lie awake with the cold, there

is a bird cry which sounds like a human one—quite startling, so that I hastily draw up the window of the tent, but can see nothing. A little while afterwards I come out of the tent, and, as I sit close to it, by the side of the rock, an Eagle "swims into my ken," and, coming rapidly up, the sitting bird, whilst he is still some way from the nest, but within its aerial region, so to speak, flies out, to join him, with the little unimpressive squeak, for it hardly deserves a better epithet. They sweep about, for a little, then one of them descends on the eyrie, but almost immediately flies off it, again, to circle with its mate, as before. After a little time, there is a second descent on the nest, and the bird seems to settle down on it, but in a minute or two leaves it, as before, and again joins the other, as Eagles understand the expression. And now, for some time, they sweep, sail, and circle, on wings spread and motionless, smoothly and largely, like planetary bodies in space, sometimes disappearing beyond the horizon of the cliff-line, then, after a little, floating up again, passing and sweeping away from one another, returning "from the ends of opposed winds" and re-meeting "as over a vast," never really together, often widely asunder, yet still in a spacious companionship; for the speed at which they move, in their effortless flight, as, no doubt, their great range of vision, extends the limits of neighbourhood, for these birds, far beyond our own poor conception of it—great fields of air are as a cosy corner to them. Much finer cries now drop from the air, but these are so Gull-like in their intonation that as the Eagles have now passed beyond the hemmed-in limits of where I can see to, I cannot feel sure that it is they who are uttering them. No Gulls, however, come into sight, and the cries seem stronger and wilder than anything I have heard Gulls utter. They are wild and impressive, and their strength seems proportionate to the size of these great, lordly birds. All this, however, may be—probably is—due to imagination.

It is about 4.45 a.m., when one of the Eagles comes down, with a fine, rushing swoop, on the eyrie, where it stands in full view, for some seconds, before sinking down into the cavity of the nest, which unfortunately, with the exception of the head, hides it completely—for I am looking up at, not down into it. I cannot even see the nest itself, but only the spot where it is,

amongst the green grass and moss of the ledge. I cannot now say which of the two birds it is, the one that flew off the nest to join its mate, or this latter.* One fact seems establishing itself, *viz.* that the sitting bird does not wait on the nest for the other to relieve it, but flies out to it, when it appears. It is now 5.30 a.m., and the Eagle is still sitting.

A little while after this, the tent having sagged down considerably, being one of the few vices (another was leaking) which I found it in time to possess, I very unfortunately went outside, again, in order to tighten the cords, and, as I came round it, saw one of the Eagles quite near. I am caught, as it were. Which one it is, I cannot say, but as I creep into the tent again, and look through the window, I see both of them sailing together. They float away, and return again, several times, sometimes uttering the disquieted cry of yesterday, that which has been called a bark, though it has only a fanciful resemblance to one. One then makes, once or twice, as if about to descend on the eyrie, but appears to think better of it, both pass together over the brow of the cliff, and up to now (6.45) they have not returned.

At 7 one of the birds flies close over the nest, but does not go down on it.

7.45.—Both are now back, in the neighbourhood, and one passes close above the nest twice (unless each does so successively), but still without alighting. I cannot discover that the birds show any apprehension. I have heard, just before, the little squealing cry, which seems to be one of greeting, and not of alarm.

8.5.—One of the Eagles down on the nest, and broods the eggs with great care, spreading its wings, and, as it were, flattening itself on to them. The white tail is also spread out, and, as it seems, moved from side to side. This is what I seem to make out before the bird disappears in the cup (if it has one) of the nest. What object these actions may serve, or whether they stand in any special relation to the eggs, it is not easy to say.

* At this stage I had not come to distinguish the two surely. The female, however—or the one that, almost alone, brooded the eggs—was more hoary than the male, who was browner. Relative size, under the conditions, was not a very distinguishable feature.

8.25.—The other Eagle passes, at a height, and I see him again, thus sailing, a little while afterwards, farther off. At 10.15 he again appears, floating grandly in the high air. It would appear to be the general habit for the one bird to keep on guard whilst the other sits. But this is not constant, for during the whole time of setting up the tent yesterday—it can hardly have been less than two hours—the non-sitting bird was away. Had it been anywhere in the neighbourhood—anywhere, that is, but *far* away—when we came the second time, it must have seen us, and would no doubt have kept, for some time, at least, near about—as construed in its own wide way—in a state of disquietude, as it did before.

Just a little before 1 p.m. (during most of the interval I have been asleep) the sitting bird—the bird then sitting, that is to say—comes off the nest. For a moment or two after its first float upwards, it raises the wings, sinks the legs, suspends the motive impulse, and appears to go through the actions of stretching itself, in the air, after the long hours of incubation—for I doubt not it has been on the nest all the while. It then floats, in its habitual manner, and, being joined by its mate from over the crest of the cliff-line, the two sweep and circle in the most magnificent manner. Nothing has ever been said or imagined, or could be said or imagined, to rival in, descriptive force, the actuality of grace, power, and majesty exhibited in the flight of these birds. It is a thing so superb and beautiful to see—now in the midst of an azure sky and air flooded with sunlight, over waters as blue and as bright—that, seeing it, one wonders how anyone who ever had the like grace vouchsafed him could wilfully do, or wish to do, anything to diminish the numbers of so grand and glorious a being. Simply for the purpose of keeping such beauty in the world, there might well be societies to protect it, even though not one in ten—or ten thousand—of their members knew of it other than by repute; just as one might worthily join such a body, to save the great sculptures of antiquity from destruction, though one never had seen or were likely to see very many of them. That such a sight should cease out of the world makes the heart, as one gazes on it, sick to think upon. Still they float, and in a sky that might overarch Mount Olympus. Magnificent, however, as is the flight of the

Eagle, there are not a few who consider its blown egg, in a cabinet, a still grander object of contemplation.

After the two Eagles have thus floated and circled together—a large togetherhood—one of them, with a great rush of wings, shoots down, in a slant, towards the lake, and sweeping on, close to its surface, when seeming on the point of immersing itself, just dips with his claws, and floats upwards to the peak of a cliff. Here he alights, and, though the distance is great, I can see him, through the glasses, once or twice lower his head to his feet, and raise it again, after the manner of birds of prey, when feeding. It seems evident, therefore, that he has caught a fish, yet I could make out nothing in his claws as he flew. Probably they were pressed to the breast, and hidden amongst the feathers, the fish being only a small one. After the meal, the birds continue their wheelings, and I notice that whenever they pass over the headland, at the end of the line of cliffs, they are assaulted by a bird that looks like a speck in proportion to them. It gives, at the distance, the impression of a mere Sparrow—a "small bird"—but the glasses show it to be one of the Eagle's own kind. It must be, I think, a Merlin or a Hobby—probably the former. Evidently a pair of them have their nest in the cliffs of this headland. The little doughty knight dashes at its big relatives, most temerariously, and, as shown by their manner of avoiding it, is evidently an annoyance to them. It is possible, even, that they cannot avoid its small activity, and get a peck or two, but this I cannot quite make out.

After this both Eagles disappear for some time, and it is not till 2.30 p.m. that the female floats up alone, and comes down on the nest or the nesting-ledge. But, in the same way as yesterday, she goes up again almost directly, and it is not till 4.45 that she returns and broods the eggs. At 7.40 she comes off, and floats majestically around, as though enjoying the relaxation, offering a splendid spectacle. Then, as before, she descends on the eyrie, only to stay there an instant, and, having descended upon various peaks and pinnacles, floats out of sight. At 8.20 she returns and re-broods the eggs, but leaves them again at 9 (for which possibly I am responsible); and now, as she sails grandly about, she is mobbed by a party of three Gulls—Great Black-backeds—who dash at her—sometimes a pair of

them, sometimes all three together—with reiterated cries. So close do they come, as they dash at her, that one might think they really meant to peck her, but they always turn off, generally with an upward dart, before this point is reached. To the eye it looks as though there might be a foot's space between them when the swerve is made, but in reality, perhaps, it may be more. For the Eagle, she is clearly annoyed; her most pronounced motion, as the Gulls approach her, is a sudden tilt of the body, upward, on the side exposed—for it is from above that the enemy threaten—the beak being, no doubt, turned defensively, but this I cannot see. Gradually the clamour of the Gulls subsides, and at 10 both Eagles are floating together again, unannoyed.

(To be continued.)

THE DISTRIBUTION OF BRITISH ANNELIDS.

By the Rev. Hilderic Friend, F.L.S., Fellow Royal Microscopical Society.

(Continued from vol. xv. p. 374.)

27. Middlesex. — Numerous records will be found under Chelsea and Kew which may be of service, but in those cases we have to remember that foreign influences have been at work. Reference may also be made to "Some Annelids of the Thames Valley," contributed by me to the Linnean Society, 1912, for notes on annelids other than *Lumbricidæ* found in and around Middlesex. In 1892 I contributed to 'Science Gossip' an article entitled "The Earthworms of Middlesex," in which all that was then known on the subject was summarized. I find, on reference to this article, the following species are recorded:— (1) *Lumbricus terrestris*, L., from Miss Edwards, of Haydon Hall, Eastcote, near Pinner, who wrote as follows: "Reading this morning in 'Science Gossip' that you want worms, I am sending a few dug up in a copse, in our garden, and found under logs or in the mud at the edge of a pond in the said copse." The specimen was interesting, as it had papillæ on segment 11, but none on segment 15, where the male pores are found. On the occasion of a visit to the "Zoo," I found one specimen of the same worm in Regent's Park, but the *Common* Earthworm appears to be rare in Middlesex. (2) *L. rubescens*, Friend (= *L. festivus*, Dugès) was taken at Hornsey, but this again appears to be rare. (3) *L. rubellus*, Hoffm., seems to be more common, and was recorded as occurring at Hornsey and Pinner; while the same localities also yielded (4) *L. castaneus*, Sav. Passing to the genus *Allolobophora*, I find (5) *E. fœtida*, Sav., or the Brandling recorded by Dr. Gray for Hammersmith. Mr. Chaloner dug up specimens for me in his garden at Hornsey, and Miss Edwards sent a capital series from Eastcote. It was accom-

panied by (6) *Dendrobæna subrubicunda*, Eisen, plentiful in both localities in garden refuse and vegetable mould. The Green-worm (7) *A. chlorotica*, Sav., is noted, though specimens had not been seen by myself; and (8) *A. turgida*, Eisen, was reported as received from Miss Edwards. The long worm (9) *A. longa*, Ude, was found in Regent's Park and Hornsey, and this is the worm which usually passes muster as the Common Earthworm. Reference is also made to another species (doubtfully named *A. complanata*, Dugès), but so far I have failed to obtain further light as to the species. Nor has time brought us any nearer a solution of the question what Oerley means by *A. rubida*, which he reported for Woolwich. So many changes have been made in nomenclature in the course of time that it is sometimes a little difficult to be certain about the earlier records. Chronologically they stand as follows:—1865, 'A Catalogue of British Worms,' by Dr. Johnston, in which *L. terrestris*, *L. minor*, *L. anatomicus*, and *L. fœtidus* are credited to Dr. Gray, with Hammersmith as the locality. 1885, Oerley, 'A Palæ. övben elo terri. rev.,' reports *O. complanata*, Oerley, and *O. rubidum*, Oerley; but the species remain in doubt. 1892, Mr. Chaloner, of Hornsey, collected for me, on March 28th, *Eisenia fœtida*, *A. longa*, *A. turgida*, *D. subrubicunda*, *L. castaneus*, *L. rubellus*, and *L. festivus* (= *L. rubescens*). Miss Edwards sent me shortly after *E. fœtida*, *A. turgida*, *D. subrubicunda*, *L. castaneus*, *L. rubellus*, and *L. terrestris* from Eastcote. Dr. Woodward wrote me on April 11th, 1892, respecting an earthworm described by him, which he believes, on the authority of Beddard, to be *A. longa*, a worm which is frequent in Regent's Park and elsewhere. There seems to have been nothing done on this important subject during the past twenty years, and the list still stands very low. Total authentic species, 9.

28. Norfolk.—The records for this county have recently been carefully tabulated for the 'Trans. Norfolk and Norwich Nat. Soc.,' and the history may be read in vol. ix. pp. 394–405. Aided by Mr. Robert Gurney, at whose laboratory I worked in the summer of 1911, and Mr. Mayfield, I have been able to record fifteen species of *Lumbricidæ*, besides many species of *Enchytræidæ* and *Tubificidæ*. They stand in the following order in my report:—(1) *L. terrestris*, (2) *L. castaneus*, (3) *A. chlorotica*, (4) *Allurus*

tetrædrus, (5) *A. longa*, (6) *A. turgida*, (7) *Eisenia rosea*, (8) *O. lacteum*, (9) *L. rubellus*, (10) *E. fœtida*, (11) *Dendrobæna arborea*, (12) *Bimastus eiseni*, (13) *D. subrubicunda*, (14) *L. rubescens* (=*festivus*), and (15) *O. gracile*. Total, 15.

29. NORTHANTS.—My study of the annelids of this county dates from 1891. During that year I received from Mr. Henry Blaby, of Brackley, sundry consignments containing eight well-defined species. Concerning these and some others an account appeared the following year in two articles contributed to the 'Field Club.' My original records stand thus:—(1) *L. rubellus*, (2) *A. turgida*, (3) *A. chlorotica*, (4) *A. longa*, (5) *L. terrestris*, (6) *L. castaneus*, (7) *D. subrubicunda*, (8) *Eisenia rosea* (= *A. mucosa*). In February of the following year (1892) I received (9) *Eisenia fœtida*, and in revising the material found also (10) *D. arborea*. In April a further consignment brought me, in addition to the foregoing, (11) *D. mammalis* (= *celtica*), a form which I have named (12) *A. cambrica*, which needs revision in the light of modern research, and a species of *Octolasium*, which must be referred to (13) *O. profugum*, because the tubercula extend over segments 31–34. Eight of the foregoing species reached me again on June 7th, 1892. One or two other species of a critical character still remain doubtful, but it seems pretty clear that *constricta*, *putris*, and *eiseni* are to be found there. Total record 13.

30. NORTHUMBERLAND. — The only records for this county known to me are found in Dr. Johnston's 'Catalogue of British Worms,' published in 1865. Some of these it is difficult to determine, but it seems clear that six species were then known. In the terms of modern science these may be given as: (1) *L. terrestris*, (2) *L. rubellus*, (3) *A. longa*, (4) *A. chlorotica*, (5) *Eisenia fœtida*, and (6) *L. festivus*. These are credited to Dr. Johnston himself, who found them at Berwick. Total record, 6.

31. NOTTINGHAM.—This county has received a good deal of my attention, largely through the kind aid of Prof. Carr, M.A., and I am publishing my results from time to time in the 'Trans. of Notts. Nat. Society.' Reference may be made to this publication for details (1910 and following years). The list contains:—(1) *Allurus tetrædrus*, with var. *luteus*, Friend, (2) *Eisenia rosea*, (3) *E. fœtida*, (4) *A. caliginosa*, including both *turgida* and

trapezoides, (5) *A. longa*, (6) *A. chlorotica*, (7) *D. subrubicunda*, (8) *D. arborea*, (9) *D. mammalis*, (10) *B. eiseni*, (11) *Octolasium lacteum*, (12) *O. cyaneum*, (13) *O. gracile*, (14) *L. rubellus*, (15) *L. castaneus*, (16) *L. terrestris*. Some very interesting discoveries have been made during the past year, and it was a pleasure to find (17) *Helodrilus oculatus*, Hoffm., in a locality which places it beyond suspicion as a native Lumbricid. This is one of the finest county records, totalling 17 species.

32. Oxfordshire.—My researches into the Annelid fauna of this interesting county go back over two decades. In 1892 my Brackley correspondent, Mr. Henry Blaby, sent me consignments, particulars of which were published in the 'Banbury Guardian' of Aug. 25th. This was, so far as I can discover, the first occasion on which any attempt was ever made to deal with the subject scientifically. The collection included seven species, *viz.* (1) *L. rubellus*, (2) *L. castaneus*, (3) *A. chlorotica*, (4) *A. trapezoides*, (5) *Eisenia rosea* (= *A. mucosa*), (6) *D. subrubicunda*, and (7) *D. mammalis* (= *celtica*). When twelve years later (April 7th, 1904), I addressed a letter to the same paper on the subject, it was possible to add five further species to the list. I had earlier in the year paid a personal visit to the University City, and examined the Botanic Gardens, and a worm was found on that occasion which, though numerous there, has hitherto been found nowhere else. This was (8) *Eisenia veneta*, var. or subspecies *tepidaria*, Friend; (9) *Allurus tetrædrus* was found by the river, (10) *O. cyaneum* in the Gardens, (11) *A. longa* on the pavement near the Martyrs' Memorial, and the twelfth species was the Brandling (12) *Eisenia fœtida*. In May, 1904, under the presidency of Dr. Veley, I gave a lecture before the members of the Ashmolean Nat. Hist. Soc. on British Annelids, with special reference to Oxford, and was able to record fifteen native species. To the foregoing had been added (13) *L. terrestris*, (14) *O. profugum*, and a species which I mistook for *A. tyrtæa*. Later examination, however, showed that this was new to science. In the 'Gardeners' Chronicle' for March 12th, 1904, I gave an account of some of the worms, figuring *O. cyaneum*, which was new to Britain, and the girdle of *tepidaria*. But it was not till Nov. 27th, 1909, that I published in the same paper an account of the new Oxford worm, which now appears as (15) *A. inter-*

media, Friend. So far the species seems never to have been found elsewhere. In 1902 Mr. Günther published a 'List of Oxford Annelids,' which I compiled at his request, which agrees with the foregoing. It also notes a second variety of *Eisenia veneta*, found in the Gardens, but as yet unnamed. The Gardens have not been carefully worked for Annelids any more than the county generally, or our list might probably be considerably extended. Authentic list, 15.

33. RUTLAND.—No records. The records for Scotland, Wales, and Ireland are not given in the present contribution. For Sheppey, *see* Kent and the Thames Valley paper.

34. SHROPSHIRE. — In May, 1909, I had occasion to visit Shrewsbury, and during my stay there worked a little at the Annelids. The gleanings were not rich, but contained (1) *L. rubellus*, (2) *A. trapezoides*, (3) *A. chlorotica*, (4) *A. constricta* (a worm which appears to be somewhat rare and local), and (5) *Allurus tetrædrus*. In October of that year Mr. H. Forrest sent me, in addition to the first three named above, (6) *L. terrestris*, (7) *L. festivus* (which is the rarest of the true Lumbrici in England), (8) *A. longa*, (9) *A. turgida*, and (10) *Octolasium studiosum*. A little later (Oct. 21st) were added (11) *L. castaneus*, and (12) *D. subrubicunda*. In November I again visited Shrewsbury, in order to try and ascertain what worms had helped to bury the old Roman city. We then found (13) *D. arborea*, (14) *Eisenia rosea*, and (15) *D. mammalis*. In May, 1910, Mr. Goodwin sent a collection from Uffington, containing *A. longa*, *E. rosea*, *O. studiosum*, *D. subrubicunda*, and (16) *E. fœtida*. This latter worm, known as the Brandling, is common in old gardens and manure, but had not previously been met with in Salop. Authentic county list, 16.

(To be continued.)

NOTES ON THE YARMOUTH HERRING FISHERY OF 1912.

By Thomas J. Wigg.

The autumn fishing commenced much earlier than usual this year, and those connected with this industry began to arrive at Yarmouth and Lowestoft during the third week in September, but it was not until near the end of the month that work was begun in earnest. Great preparations had been made for an early start, and merchants and their workpeople gathered from all parts of the English and Scottish coasts in readiness for the harvest of the sea.

A large number of boats were at sea during the last two or three days of September, and, meeting with a great shoal of Herrings within easy distance of Yarmouth and Lowestoft, heavy catches were made, and about 20,000 crans (1000 fish = 1 cran) were landed at each port in one day. Prices at this time ranged from 32s. 6d. to 20s. per cran, according to quality and the quantity landed. A Yarmouth boat, the 'Sunbeam,' beat all records by making a haul of 320 crans (or approximately 320,000 fish). Two boats were required to bring this prodigious catch to port. The fish, when sold, realized £520.

All boats were not so fortunate, for during the middle of October the catch and delivery were so great that thousands and ten thousands of crans of Herrings were landed day by day. On Monday, Oct. 12th, about 200 boats came in with the great average catch of 50 crans, and on Tuesday about 150 Scotch boats swelled the great catch by an average of 60 crans per boat, with the result that prices fell to 10s. and 12s. a cran. Wednesday's catch averaged 35 crans from 250 boats, while the 500 boats which arrived on Thursday brought in a total of 25,000 crans.

Lowestoft boats also made remarkable catches during this week, and showed a total of over 80,000 crans more than at the

corresponding period of last year. The great catches of October were continued well into the first or second week of November, when the weather became unsettled, and the fishermen were in the same position and anxious to end the season. Many Scottish crews, having made a good fishing, were anxious to go north. I am informed that the steam-drifter, 'The Light,' returned to Fraserburgh from Yarmouth, having earned over £1000.

The abnormal catch of this season upset all calculations, and the curers found that the ordinary stock of salt and barrels was quite inadequate for the extraordinary demand.

What a change came during the last week of November! The majority of the Scottish boats had returned to the north, and the deliveries of fish were very poor.

In former years the season has lasted close up to Christmas, but compared with last year some strange results may be noted. In 1911, the month of November was nearly over before the heavy fishing began, whereas this year the great catches were all over in the early days of that month in 1912. Compare the figures for the week ending Nov. 16th. At Yarmouth the catch for the week was 18,866 crans, and in the corresponding week of 1911 it was 70,696, but the *season's* catch on the same date was 151,770 crans better than at the corresponding period of 1911.

'The Fish Trades' Gazette' of Dec. 7th, 1912, says:—"From every point of view the fishings at the two chief centres (Yarmouth and Lowestoft) have been an unqualified success. The quantity of Herring caught creates a record in the history of the trade. . . . The thousands of shore hands employed in the great industry have also profited by the bountiful harvest of the sea. . . . There may be—indeed, there are—a few fishermen, as is always the case, who have been unfortunate in the loss of gear, but, taken on the whole, there has never been a Herring fishery in East Anglian waters, or anywhere else, which has been of so much general benefit, and for which there is so much occasion for all-round gratitude."

The following statement shows a Return of Herrings landed at Great Yarmouth and Lowestoft in 1912:—

At Fish-wharf :—

Month.	Crans.	Month.	Crans.
April	13½	Brought forward ...	6,046
May	251	September	97,019
June	105½	October	397,145
July	226	November	102,219
August	5,450	December ...	2,548
Carried forward	6,046	Total	604,977

At Gorleston :—

Sept. 14th to 30th	5,976
Oct. 1st to 31st	57,965
Nov. 1st to 23rd	7,818
	71,759

At other Wharves :—

September	39	Fish-wharf	604,977
October	6,110	Gorleston	71,759
To Nov. 9th	1,473	Other wharves	7,622
	7,622		684,358

The number of Yarmouth boats was about 204
„ „ Scotch and other boats was about 732
Total 936

Return of Herrings landed at Lowestoft in 1912 :—

Month.	Lasts.	Month.	Lasts.
January	9	Brought forward ...	196
February	—	July	31
March	5	August	85
April	94	September	4,241
May	81	October	29,773
June	7	November	7,990
	—	December	394
Carried forward	196	Total ...	42,710

This quantity is equal to 427,100 crans.

The number of Lowestoft boats was about 337
„ „ Scotch and other boats was about 311
Total 648

NOTES AND QUERIES.

MAMMALIA.

The Hedgehog in the Highlands.—Gathering from some recent remarks by Mr. J. A. Harvie-Brown and others, in 'The Scottish Naturalist' and elsewhere, that the Hedgehog is considered to be rare—if not of recent introduction—to some parts of the Scottish Highlands, I have turned up some of my old journals, and the following results may perhaps be worth putting on record:—In 1877 I saw a Hedgehog on the side of Ben Cruachan, on the slopes facing the Pass of Brander, and allowed it to continue its way unmolested. This is, of course, on the north bank of Loch Awe, in Argyllshire. It is well known to gamekeepers in that county, in several places; a few, for example, are still killed annually in the neighbourhood of Glendaruel. In Glen Urquhart, Inverness-shire, it used to be trapped in numbers some twenty years ago, and is doubtless still not uncommon there. On April 13th, 1887, I had noted having passed "a dead Hedgehog lying at the roadside," in walking from Loch Maree Hotel to Kinlochewe, in Ross-shire. From recollection I think this was near Talladale Bridge, and I believe I have seen others in that county, though up to the present I have not found any notes made of them. No doubt the animal must be known to many of your readers to occur in these and probably many other Highland localities, but records of "common things" are rarely considered to be worth while putting into print, and the often-felt want of them must be my excuse for thus troubling you.—George Bolam (Alston, Cumberland).

Albinic Example of Mus sylvaticus.—A very beautiful specimen of a perfectly white Long-tailed Field-Mouse has been brought to me. It was one of a litter of six, the rest of the family being of the ordinary colour. The nest was made in a stubble-field near this village, and was turned up by the plough. It can be imagined what the very prominent beady eyes of a Field-Mouse are like when they resemble drops of Stephens's red ink—that is the nearest description of their colour. The little white one has been reared by hand, and has become very tame, though at one time it used its teeth freely on being handled. By diligent search, which, however, may have missed an entry, only one instance of an albino Long-tailed Field-Mouse has been found throughout the whole series of 'The Zoologist' from

1843, and this is reported (1884, p. 226) as having "the slightest possible tinge of colour." One also was mentioned in the 'Field' for Jan. 18th, 1873. Three years ago, so one of the gardeners tells me, he caught a pure white specimen with pink eyes whilst moving sheaves of oats in a field close to this village; it was full-grown, but died a day or two after capture. This looks as if there may be some family connection between these two albinos.—H. MARMADUKE LANGDALE (Compton House, Compton, Petersfield).

AVES.

The Ruff in the Isle of Islay. — On Sept. 11th, 1912, a Ruff (*Machetes pugnax*) was shot near Port Ellen, in the Isle of Islay. This species is not included in Harvie-Brown's work on the birds of Argyllshire and the Inner Hebrides, and is probably new to the fauna of the island. Mr. J. Ramsey, of Kidalton, who has taken a keen interest in the birds of this district for a number of years past, assures me this is the first authentic capture that has come under his notice. The bird—a male in winter plumage—was feeding on the banks of a small loch, and was so tame that it allowed itself to be approached within six or seven feet, and even then was loth to take wing. Unlike most waders, I have found that the Ruff will freely enter thick grass, and this individual proved to be no exception to the rule, for on one occasion I noticed the bird force its way through a patch of short but dense herbage with almost as much confidence as a Land-Rail. During my stay in the island I shot three Coal-Tits for my collection. Two of these had the cheeks very slightly suffused with pale primrose-yellow, in which respect they approached the Irish form, *Parus ater hibernicus*; the third example, however, in no way differed from the typical British bird.—COLLINGWOOD INGRAM.

Black-headed Gull in Breeding Plumage. — It may interest the Rev. H. Marmaduke Langdale, who refers to a specimen of *L. ridibundus* in summer dress, obtained on December 16th last (Zool. *ante*, p. 37), to know that in my 'Birds of Northumberland and the Eastern Borders,' p. 620, he may find references to the early assumption of this plumage on the Borders on several occasions, the earliest on December 7th, 1903, and again on 16th of the same month. On both these occasions quite a number of the birds were noticed, in the neighbourhood of Berwick-on-Tweed, with black heads. I have in addition to these a few other records of the black hood being assumed during December in Northumberland. — GEORGE BOLAM (Alston, Cumberland).

CRUSTACEA.

Large Edible Crab.—In 'The Zoologist' (1912, p. 272) reference is made to the weight to which the Edible Crab (*Cancer pagurus*) may attain. The figures given seemed to be taken very much on hearsay evidence, which is not always proof positive. When passing a local picture dealer's shop a few days since, I saw mounted on a shield in the window what I at first glance thought was a pair of small fallow-deer's horns! On a second look I found they were a pair of pincer-claws of the Edible Crab, and was allowed to measure them. The curving free chela was no less than 6 in. in length; the girth of the first section—the "hand" which contained the points—was 9 in.; and the probable length of the whole claw-leg, judging by the length mounted, would have been quite 18 in. I was given to understand the Crab was recently trawled up on the Portuguese coast. To arrive at the probable weight, when alive and "full," I purchased an 8-oz. Scotch Crab, and, measuring it, found the free chela was 1½ in., with a girth of the corresponding end section of 3 in. The carapace was 4½ in. wide by 3 in. across it, from the eyes to the back part. On this scale the larger Crab's carapace must have been undoubtedly quite 14 in. by 10 in. The entire Crab might have been 10 lb. or more in weight; my small and not very full specimen weighed half a pound. I was told that the crew of nine hands sat down to the banquet on board the trawler, unfortunately breaking the carapace in the scramble.—ARTHUR H. PATTERSON (Ibis House, Yarmouth).

PALÆONTOLOGY.

A Surrey Hippopotamus.—In the course of a report of the Asylums Committee to come before the London County Council at Tuesday's meeting, a discovery made in a part of the estate of Cane Hill Asylum, at Coulsdon, Surrey, is mentioned. The land at this spot is about 400 ft. above sea-level. In the course of the digging some bones were discovered, and Sir James Moody, the Medical Superintendent of the Asylum, having made an examination, was satisfied that they were of great antiquity. He consulted Mr. Henry Dewey, of the Geological Survey, and the authorities of the British Museum, and ascertained that the discovery consisted of remains of the head of a Hippopotamus, and two pieces of an ivory tusk, probably that of a Mammoth. The fragments comprised portions from the head of the Hippopotamus, with teeth in position in the jaw, the articulation of the jaw-bones, two of the larger teeth, and one of the vertebræ. A number of small parts of bone, so far, it had not been possible to

"piece" together. Photographs of the remains are to be exhibited at the County Hall, and the Asylums Committee suggest that they should be preserved in the Horniman Museum.—('The Observer,' Feb. 2nd, 1913.)

OBITUARY.

The Earl of Crawford, K.T., F.R.S.

The world of science sustained a great loss in the death of Lord Crawford on January 31st, at the age of sixty-six. Himself an active man of science, his lordship was in sympathy with all its branches, and the nation, as a whole, is indebted to him for much that is both valuable and interesting.

It is, however, the loss of a patron of the science of zoology that we particularly deplore in these pages. Some fifteen years ago Lord Crawford was compelled through ill-health to pass the winter months abroad in order to avoid the changes of our English climate, and it was during these years that his now celebrated yachting cruises to the South Seas and Eastern Tropics took place. The extent of these cruises may be better understood when it is pointed out that such remote localities as the islands of South Trinidad, Tristan d'Acunha, and Borneo were visited, and the stormy seas off Cape Horn negotiated.

Lord Crawford realised what great opportunities would present themselves for enriching the collections at South Kensington, and for this reason a naturalist was almost invariably numbered amongst the party on board,

Three of these voyages are described in an interesting manner by Mr. M. J. Nichol in 'Three Voyages of a Naturalist,' published some five years ago after a cruise round Africa. It is only to be expected that many new forms of birds, beasts, and insects would be collected during these trips, and the types of these, together with the whole collections made, are deposited in the National Museum. Rarely visited and remote islands always have a strange fascination for the traveller-naturalist, and it was such places as this that Lord Crawford made a point of visiting in his splendid full-rigged ship, the yacht 'Valhalla,' whose decks bore a striking resemblance to a menagerie towards the close of a long winter cruise.

As one who had the good fortune to make a long cruise to the Tropics on board her, the writer can testify to Lord Crawford's general sympathy towards Natural History and interest in strange animals and birds, whether alive or dead. His interests, however, were many-sided; a distinguished astronomer, he visited Cadiz in 1870 to witness the eclipse of the sun, and Mauritius in 1874, on the occasion of the Transit of Venus. He was elected a Fellow of the Royal Society in 1878, and President of the Royal Astronomical Society in 1878 and 1879. He was also an ex-President of the Royal Photographic Society, and a Trustee of the British Museum.

G. Meade-Waldo.

NOTICES OF NEW BOOKS.

A Vertebrate Fauna of the Malay Peninsula—Reptilia and Batrachia. By GEORGE A. BOULENGER, D.Sc., Ph.D., F.R.S. London: Taylor & Francis.

THE above is the first of a series of volumes descriptive of the Vertebrate Fauna of the Malay Peninsula, published under the authority of the Federated Malay States Government, and edited by H. C. Robinson, Director of Museums in that Dependency. It is supplemental to, and designed on the same method as pursued in, the well-known 'Fauna of British India,' and carries on the faunistic work of that publication beyond the confines of the British Indian border to as far south and east as Singapore. This important faunistic contribution to the histories of our colonies has already been followed in some volumes on the 'Fauna of South Africa,' and we may expect the enterprise to be elsewhere carried on, for it has come to stay. Such publications have a world-wide scientific value; in the Malay Peninsula they will prove a boon, indeed, to all who are interested in zoology, and we well remember a sojourn there nearly fifty years ago, when Cantor's 'Catalogues' were the principal literature for consultation.

Dr. Boulenger is particularly entitled to write this contribution, not only on the ground of his wide knowledge of the subject, but also because he did the same service to the 'Fauna of British India.' The two monographs thus become continuous, possess a common classification, and depend on the same high authority. These valuable qualifications will be properly estimated by those workers on zoological distribution who have sometimes on the same subject to consult different writers of diverse views on classification and nomenclature.

Mr. H. C. Robinson, the Editor, contributes the Preface, and gives a bibliography of the most important memoirs on Malayan herpetology. He probably omitted by accident one written by the late Dr. W. T. Blanford, "On a Collection of Reptiles and Frogs chiefly from Singapore" (Proc. Zool. Soc. Lond. 1881, pp. 215–227).

The Feeding Habits of Serpents. By Raymond L. Ditmars. Published at the Zoological Park, New York.

This booklet forms a separate part of the publication known as 'Zoologica,' consisting of contributions to the New York Zoological Society, and is the result of a long study of the feeding habits of these reptiles in captivity. The information is of a most interesting and important character, and affords support and also qualification to many zoological generalisations.

The viperine poisonous snakes are for the most part short-lived under observation, have an utter disinclination to feed, while they "remain more timid than their innocuous allies, which become readily accustomed to change of environment." Another interesting conclusion relates to the Regal Python (*Python reticulatus*) from Malaysia. From repeated examinations of the crates of newly arrived specimens of this species, Mr. Ditmars is convinced that the big specimens, when in their native environment, feed often upon the Indo-Malayan wild swine. "Examination of the excreta in sixty per cent. of a series of about forty specimens investigated showed liberal traces of the bristles of *Sus cristatus*, and in numerous cases the horny coverings of the feet." During recent years Mr. Ditmars and his assistants have discovered that an annual fast of several months' duration has increased the longevity of valuable reptiles in this collection. "The writer is convinced that the impossibility of keeping alive the big tropical vipers for more than a year's time has resulted from feeding during a period when the animal has secreted fatty sustenance to carry it past a period of hibernation or æstivation, as the case may be." More startling still is the recognition of the method by which reptiles may be employed in economic agriculture. "Members of such genera as *Zamenis*, *Coluber*, *Pituophis*, and *Ophibolus* may be regarded as of marked economic value in the vast grain belts of the United States, and their introduction into localities infested with the smaller sciurine rodents is well worth serious trial and extended observation. The species of *Pituophis* should be particularly useful owing to their strictly terrestrial habits and inclination to prowl into the burrows of small mammals."

This excellent publication is beautifully illustrated.